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SITE INDICES
for Northern Hardwoods
in the Green Mountains of Vermont

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Preface

THE study reported in this paper was done as part of a cooperative project of the Northeastern Forest Experiment Station and the Vermont Agricultural Experiment Station. Portions of this study were conducted as part of a Northeast Regional Project (NE-27), which is a cooperative project involving agricultural experiment stations in the Northeastern Region and supported in part by regional project funds of the United States Department of Agriculture. Publication approved by the Vermont Agricultural Experiment Station as Journal Series Paper No. 107.

Comparative SITE INDICES for Northern Hardwoods in the Green Mountains of Vermont

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Introduction

IN DETERMINING the productivity of a certain piece of forest land, it may be desirable to estimate the site index for a certain tree species even though it is not possible to use ordinary measurements of age and height. This situation may arise either because trees of the particular species are not now present in the stand, or because trees of this species that are present in the stand are not suitable for use in determining site index.

Under either of these circumstances, estimates of site index for the desired species may be obtained by either —

- estimating equations that relate site index to measurable characteristics of the soil and topography,

or

- estimating equations that relate site index for the species in question to the site indices of other suitable species that are present on the same land area and for which the proper age and height measurements can be made.

The first approach is more generally applicable; however, the results of detailed studies must be available as a basis for the equations, and their application may require specialized knowledge.

In the second approach, the results of detailed studies must also be available, but determination of the equations is relatively simple; and, where conditions permit their use, the equations are easily applied. Several workers in recent years have published equations or graphs for predicting the site index of one species from another, within specific regions. Good reviews of the literature on the subject are given by Doolittle (1958) and Foster (1959).

Using this approach, the authors have developed comparative site indices for northern hardwoods — white ash, hard maple, yellow birch, and white birch—in the Green Mountains of Vermont. If the site index for one of the species is known, it can be used to estimate site indices of the other three species for the same land.

The Data

Site indices for four northern hardwood species were determined on a series of 78 plots located in even-aged second-growth stands on soils developed on acid glacial till in the Green Mountain region of Vermont. Site index, at a reference age of 75 years at breast height (b.h.), was determined for sugar maple, white ash, yellow birch, and white birch. The new site-index curves of

Table 1. — Values of the correlation coefficient ("r") for comparisons of site index values for northern hardwood species occurring on the same plots

Comparison	Correlation coefficient	Number of plots
Sugar maple — white ash	0.94**	43
Sugar maple — yellow birch	.91**	36
Sugar maple — white birch	.80**	35
Yellow birch — white ash	.94**	16
White birch — white ash	.83**	20
White birch — yellow birch	.88**	23

**Significant at the 1-percent level.

Table 2. — Equations relating the site index of sugar maple, white ash, yellow birch, and white birch

	Equations
SI_{75} of ash	$= 1.28$ (SI_{75} of maple) -13.56
SI_{75} of yellow birch	$= 0.96$ (SI_{75} of maple) -0.27
SI_{75} of white birch	$= 1.01$ (SI_{75} of maple) -0.26
SI_{75} of white birch	$= 0.60$ (SI_{75} of ash) $+27.56$
SI_{75} of yellow birch	$= 0.63$ (SI_{75} of ash) $+21.30$
SI_{75} of white birch	$= 1.14$ (SI_{75} of yellow birch) -7.22

Curtis and Post (1962), which had been constructed earlier from the same plot data, were used. Where possible, at least two sample trees of each species were measured on each plot. Generally, more than one species was present on any one plot, but usually not all four species were present.

Analysis and Results

Correlation coefficients for each of the possible comparisons of site index by species were calculated. They are given in table 1. All were significant at the 1-percent level.

Equations for the relationships between site indices of different species were calculated by the least squares methods given by Deming (1943, p. 184) for situations where both variables are subject to error. Plot observations were assumed to be of equal precision for all species. The resulting equations, given in table 2, can be used to estimate either variable, as long as the other variable (site index) is known.

The chart (fig. 1), showing these relationships among all four species, was prepared from the equations presented in table 2. The chart illustrates the relationships of the site indices of the four species on the same land. Although it does not express these relationships quite so accurately as the equations do, this chart can be used to obtain estimates of the site indices of the other three

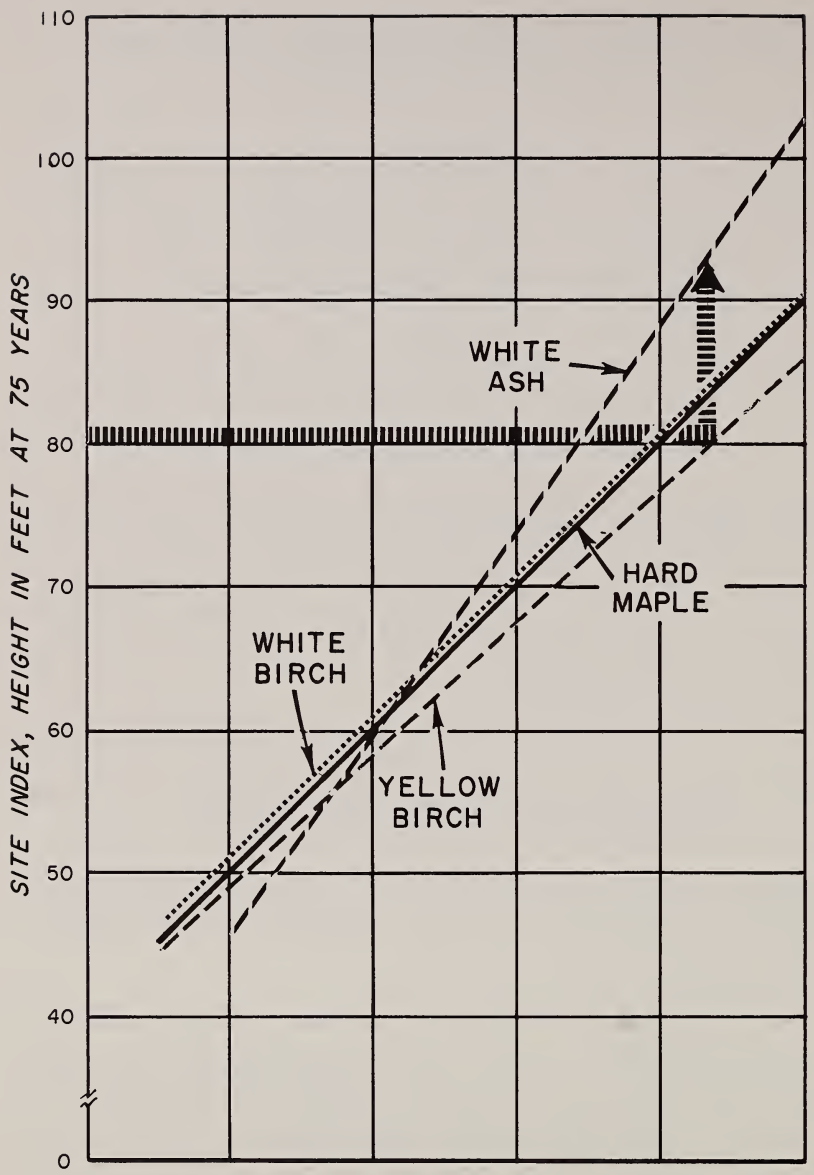

Figure 1. — Comparative measured site indices for four northern hardwood species on acid till soils in the Green Mountains of Vermont. Base age used was 75 years at breast height. If the site index of one species is known for a given piece of land, the site index of any of the other three species can be estimated.

For example, if the site index for yellow birch is 80, and you want to know site index for white ash: start at 80 on the site-index scale and read right to the yellow birch curve, then read straight up to the white ash curve, and read left to get site index — 93.

species if the site index is known for one of the four species. It is also more convenient to use than are the equations.

For example: suppose you would like to know the site index for white ash on a certain piece of forest land, but there are no white ash trees in the stand. But there are some yellow birch trees, and their site index is measured as 80. So, on the chart, take 80 on the site-index scale as a starting point, and read right to the curve for yellow birch; then read straight up until you strike a point on the curve for white ash. From this point read left to the site-index scale, and you get a reading of 93. The comparative site index for white ash on this site is 93.

Discussion and Conclusions

The use of such relationships for predicting site index involves a number of assumptions and limitations.

First, the method assumes that growth of each of the several species is related to the same basic factors of the environment (site). For these species and the range of sites studied, this seems a reasonable assumption.

Second, those plots on which the species compared occur together may not be fully representative of the entire range of sites because, as a matter of observation, species composition is related to site in some degree. Obviously the method cannot be used to estimate site index of a species on sites on which the species does not normally occur. However, within the range of conditions studied, this is not believed to be a serious limitation.

Third, application of the results given here should be restricted to stands and sites similar to those used in deriving the equations given — even-aged second-growth stands on acid till soils in the Green Mountains. They are not applicable to uneven-aged stands, and their applicability to other soils and regions is not known.

But, even with these limitations, it appears that knowledge of site index for one of the four species does give considerable information on site index for the other three species.

It is interesting to note that in figure 1 the relative slopes of the curves for the various species can be interpreted as an indication of the relative sensitivity of the species to differences in site quality of land. Thus, it is clear that of the four species, ash has the lowest site index on low sites and the highest site index on the high sites; hence, ash is clearly the most sensitive to differences in site quality — a fact that is generally recognized (Wright, 1959). Yellow birch appears to be slightly less sensitive than hard maple, though doubtfully distinct. This accords with the general observation of the authors that—in the even-aged stands studied—yellow birch appears to have difficulty competing with the associated ash and maple on the best sites.

It is also well to note that the relative heights of these curves depend in part on the reference age used for site index. Thus, white birch, a short-lived species that makes rapid early growth, would be considerably above the curves for yellow birch and sugar maple if site index were expressed as height at age 50 years b.h. rather than 75 years b.h.

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